Co-Metabolic Biological Reactions for the Treatment of MTBE-Contaminated Groundwater

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RESEARCH OBJECTIVES

Approximately 70% of all gasoline in the United States contains methyl tert-butyl ether (MTBE). As a consequence, MTBE has become a widespread groundwater contaminant. Biological treatment of MTBE-contaminated groundwater has only recently been considered as a potentially applicable technology. Several investigators have been able to maintain MTBE-biodegrading treatment systems in the laboratory. In all cases the reactors exhibited slow growth, were difficult to start, and were generally unstable, being easily subject to a loss of MTBE treatment efficiency.

The objective of the research presented here was to determine a biological process by which MTBE-contaminated groundwater could be treated. Once the mechanism was determined, field and laboratory tests were conducted to evaluate improved techniques for MTBE biological treatment.

APPROACH/ACCOMPLISHMENTS

The original hypothesis of this project was that organisms able to grow on MTBE as a sole carbon and energy source could be used in MTBE treatment. Enrichments from groundwater treatment systems produced three strains of bacteria and a fungus that were able to degrade MTBE in liquid culture. The growth of bacteria on MTBE was poor. In many cases, MTBE enrichments would not maintain MTBE degrading activity after multiple transfers.

The poor growth, low activity and instability of the MTBE-degrading cultures raised several issues concerning the utility of growth-based transformation processes in MTBE biotreatment. It was proposed that co-metabolic biodegradation could be a more reliable mechanism for MTBE biotreatment. The focus of this research shifted to determining what supplemental carbon sources could serve as co-metabolites for MTBE degradation. Enrichment cultures grown on iso-pentane consistently demonstrated MTBE degradation activity (Figure 1). MTBE degradation appears to be a constant characteristic of iso-pentane degraders.

Experiments and field tests are being conducted to examine the use of iso-pentane as a co-substrate for MTBE degradation. Tests in laboratory reactors have shown that iso-pentane addition can stimulate MTBE removal (data not shown).

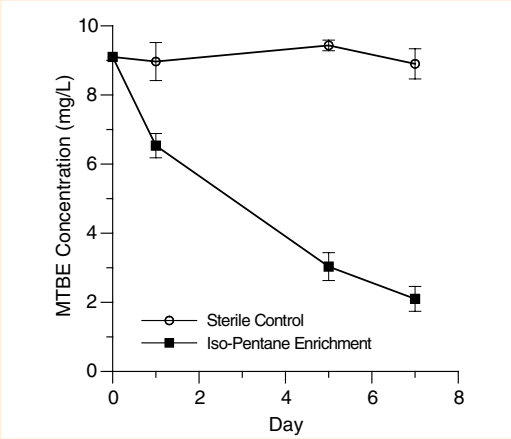

Figure 1. Degradation of MTBE by an iso-pentane enrichment. Mean plotted with error bars of one standard deviation.

SIGNIFICANCE OF FINDINGS

Laboratory and field data support the argument that the primary mechanism for MTBE removal in fluidized-bed reactors treating contaminated groundwater containing gasoline hydrocarbons will be co-metabolic biodegradation. Gasoline range alkanes, particularly iso-pentane, can serve as reliable co-substrates for the stimulation of MTBE biodegradation. Future research will focus on the use on iso-pentane as a co-substrate for MTBE degradation under field conditions.

RELATED PUBLICATIONS

Stringfellow, W.T., R.D. Hines, D.K. Cockrum and S.T. Kilkenny, Factors influencing biological treatment of MTBE in fixed film reactors, in G.B. Wickramanayake, et al. (eds.), Bioremediation and Phytoremediation of Chlorinated and Recalcitrant Compounds, pp. 175-181, Battelle Press, Columbus, Ohio, Berkeley Lab report LBNL-45487, 2000.

Stocking, A.J., R.A. Deeb, A.E. Flores, W.T. Stringfellow, J. Talley, R. Brownell and M.C. Kavanaugh, Bioremediation of MTBE: A practical perspective, in Biodegradation (in press), Berkeley Lab report LBNL-45016, 2000.

Stringfellow, W.T., R.D. Hines and S.T. Kilkenny, Applying co-metabolic biological reactions for the ex-situ treatment of MTBE contaminated groundwater, Berkeley Lab report LBNL-45018Abs, American Chemical Society National Meeting, San Francisco, Calif., March 26-30, 2000.

Stringfellow, W.T., Using iso-pentane to stimulate MTBE biodegradation in groundwater treatment systems, Berkeley Lab report LBNL-45017Abs, EPA MTBE Biodegradation Workshop, Cincinnati, Ohio, Feb. 1 – 3, 2000.

ACKNOWLEDGEMENTS

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